

corresponding advances in connection with the spectro-scope and sidereal photography. The three combined constitute a distinct feature in the more modern methods, by which we are gradually becoming better acquainted with the infinite remote. So soon as molecular physics shall have made, as is promised, a like advance, then the infinite minute also will be brought more distinctly within the human ken.

With regard to the Harvard volume on Sidereal Photometry, without unreservedly conceding to it all the accuracy to which it lays claim, it must be gratefully acknowledged that it provides astronomers with a consistent and valuable catalogue of stellar lustre which, in a complete form, had not hitherto existed. It dispenses with the too often unreliable and discordant estimates of the past, and replaces them by scientific measures possessing, to say the least, considerable precision.

The two parts of the volume contain together no less than 512 closely-printed pages, many of them abounding with models of condensation, and constituting in themselves a remarkable instance of sustained and successful scientific labour. They embrace not only the general history of the subject to which the volume refers, but they at the same time combine elaborate criticism and valuable comparisons of the results of preceding labourers in the same field.

In the first part there is given a description of the meridian photometer, with which the measures of comparative lustre of the stars are obtained. In it are most ingeniously combined the more valuable and least dangerous devices which are found in the instruments devised by Sir John Herschel, Steinheil, and Zöllner. Taken as a whole, the instrument may be properly regarded not only as ingenious but as original. Roughly speaking, it consists of two contiguous telescopes placed horizontally nearly in the meridian, each of the object-glasses being armed with a reflecting prism, so that the light from Polaris and any other star may be brought into the same field of view, after having passed through a double-image prism. The images are then viewed through a Nicol prism, and, by means well known to physicists, the light of the one star is reduced by a measurable amount until it is adjudged to be equal to that of the other star.

We trust we may be pardoned if we suggest that this construction of the instrument may possibly be too complicated to admit of that amount of precision in the measures which could be desired, and which might be obtained by simpler means. In fact, it appears from the volume itself, that at the commencement of operations, it was necessary to abandon the results of several months' work with it; and although an improvement in the use of it was subsequently adopted, we think there still remain traces of the possibly inherent difficulty of precise adjustment. The rapidity also with which the equalisation of brightness of each star with that of Polaris is made, seems hardly consistent with the requisite precision. It is to be inferred from the volume itself that as many as forty-eight final determinations, each consisting of four equalisations of the light of a star with that of Polaris, are frequently completed within the hour, in addition to the consumption of time required for finding and identifying the successive stars and adjusting them in the field of view. But, we cannot doubt, this point has been well considered by the Harvard astronomers themselves.

In the determination of the magnitude of a star, it is the usual practice to rest content, generally, with the mean of three determinations. Each determination is made on a different night, and consists of the mean of four equalisations of the lustre of the particular star compared with that of Polaris in the field of the photometer. We venture to think that the general limitation to three only is too restricted for the purposes of accuracy. The reason for this opinion is derived from the fact that on examining the numerous cases in which as many as

fifteen determinations of magnitude are made on as many nights, it is very frequently, and in fact generally, possible to find three consecutive determinations which would of themselves, in the mean, lead to a magnitude widely different from that ultimately assigned. Yet these three consecutive sets furnish no circumstance of inter-discordance among themselves which could lead to suspicion, and which might, consistently with the usual practice, have finally settled the magnitude of the star in question. We regard this not as hypercriticism, but as being the only sufficient means at hand for the examination of accuracy furnished by the volume itself.

Independently of the several catalogues containing the results of three years' unremitting labour and persevering skill, the volume abounds with the intercomparison and reduction to one scale of the work achieved in a similar direction by many preceding astronomers. The result is that astronomers who are desirous of information on the subject of stellar brightness, will probably not be disappointed if they turn to the pages of the Harvard Photometry. Combined with a memoir by Prof. Pritchard, contained in vol. xlvii. of the *Memoirs* of the Royal Astronomical Society, it is perhaps not too much to say that all that is known upon the subject up to the present date will be found easily accessible to the student.

Towards the conclusion of the volume Prof. Pickering has drawn up a very important table, which, though short, must have given him very considerable labour to compute. It contains in one summary a critical comparison of the average results of all the principal catalogues of stellar magnitude hitherto published. The Harvard Photometry is taken as the basis of the comparison, and the difference between the mean or total results of each catalogue and that of the Harvard volume is given. From the inspection of Table lxxiii. it appears that, taken as a whole, the Harvard measures indicate in the mean a brightness of the stars compared greater than that indicated by the estimates in the *Durchmusterung* of '14 mag., brighter than the mean of the *Uranometria Nova* of Argelander by '10 mag.; of Heis by '12 mag.; and of Houzeau by '11 mag. These differences, it will be observed, are all in one direction, and might appear to indicate that there is a generic difference between estimates of star magnitude by the unaided eye, and measures carefully made with a photometer such as is the meridian photometer at Harvard College, because all the estimates are apparently fainter than the measures. But this can scarcely be the true explanation, since the photometric measures also of Seidel, Zöllner, and Peirce indicate, like the eye estimates, a brightness less than that of the American determinations. Moreover, the photometric measures made by Prof. Pritchard at Oxford agree in the mean of the whole, very closely with the eye estimates in the *Durchmusterung* and the other catalogues. But, whatever the significance of this fact may be, it cannot be doubted that the Harvard volume will ever remain a most valuable addition to our knowledge in an important branch of astronomical science.

U.S. INDUSTRIAL STATISTICS¹

TO all who study anxiously social science, this is a very promising publication; its indirect testimony to the advantages of Republican institutions will be weightier to any reflective man than the eloquent tirades that are so usually bestowed upon them. It defines its object to be the stimulation and assistance of the wage-worker in his endeavour to reach a higher position. Its information respecting working men is all taken from their own contributions, a dozen pages of small print being filled with verbatim quotations from the replies of workpeople in every trade in the State, who give such

¹ "Sixth Annual Report of the Bureau of Statistics of Labour and Industries of New Jersey," 1883. Trenton: New Jersey, 1883.

varied accounts of themselves that the independence of the testimony cannot be doubted. That its work is popular is indicated by the wish expressed by one of them that "there should be a National Bureau." Factory legislation is printed in it (even 1884 legislation, although the printer's date is 1883!); the factory inspector has become a popular institution, and much testimony is borne to the smaller hardship of factory laws uniformly than loosely enforced. The more educated and more prosperous workmen are, the more ambitious and aspiring they become, and we seem on the eve of their blending with their masters when complaints are made, as here, that many of their fellow-workmen are satisfied with *only* 66 shillings a week wages; and a caution is held forth to such not to spend their money in foolishly aping the rich.

Yet, though the teacher here is no longer one of the fatherly governments of the old world using his paternal authority for the good of a rather refractory son, yet the teaching is most satisfactorily similar. Drunkenness could not be set forth as the prevailing cause of pauperism among the men or the evil of a lack of artistic taste among the masters in more vivid or unqualified terms than they are here. The sad combination of progress and poverty is bewailed, but we fear that co-operation urged here as its remedy too much overlooks the control of fashion and its effect upon supply and demand. A most practical power put in the hands of this Bureau is that of examining the accounts of co-operative companies. Any five members of a company may require such an examination.

The principal industries of New Jersey are taken, and, after full statistics of their amount, prosperity and prospects, with the wages earned by each class of workers, an interesting account is given, commencing with a short history of the methods, improvements, and general position of the trade in the United States and in other countries, and their experience compared. Any one casting about for an occupation in which he could take a satisfactory part would find in this "Book of Trades" much to supply the information first required, and much to encourage him. Among them we find a review of the silk trade, which, under the ægis of 60 per cent. duty, has made the wealthy city of Paterson; of glass-making, which at present does not extend much beyond window glass and bottles; of the cultivation of sorghum, still in its infancy in New Jersey; and of the pottery trade—after its account of which it performs the very useful function of a publication like this of appealing to such a trade to take the steps necessary for raising their standard of art. An appeal is made, not from a Government department, or from an interfering *clique* as South Kensington is occasionally regarded as being, but by the organ of his late fellow-workers, that the maker of one of those large fortunes so common in America will, for his country's glory and their help, found a technical school; while hands are led to feel that intellectual training and not mechanical energy alone is wanted. The idea is shown here also to be making its way that the school should be made the basis of technical as well as of mental training; that the dextrous use of the body should form part of the school, as well as of the playground, teaching. More than this, it is felt that they should not be two so distinct branches of education as in past days, and that the members and muscles of the body, as well as the brain, should receive elementary instruction at the school, and that the former should be placed more deliberately under the control of the latter. It is felt in America that

"The cultured mind
The skilful hand"

ought naturally to go together, and not that one should be the usual mark of the absence of the other; that, therefore, a mechanic should not mean little more than a machine, but a mechanician, able to understand, make or

repair the giant body that is using its limbs to save his exertions, and therefore a man more on a level with other men whose time has been given to the cultivation of their minds only, and more justified in insisting upon their equality with the latter. It is urged in this Report that elementary technical knowledge valuable to all the New Jersey trades may be given in ordinary schools; that technical learning is popular, frequently most so to boys who are slow at books; and that successful manual occupation improves the morality of the worst of such boys.

A very favourable notice of the Reformatory school at Coldwater; a sad tale of jail arrangements, and of methods of keeping the poor, all lead to discussions of economical difficulties felt long ago in England, not by any means avoided in America, and showing how little forms of government can modify human nature. A more hopeful view of that is afforded by the account, illustrated with three engravings and three plans, of a working-man's Institute at Millville. At this one establishment, which seems to have cost little more than 4000*l.*, are combined, besides large grounds used for field sports, bicycling, &c., a gymnasium and baths in charge of a barber in the basement, while on the ground floor are a conversation room hung round with maps and supplied with musical instruments on which performances are given, where also lectures are delivered, discussions held, and games of skill played. Side by side with it is a library and reading-room. Up stairs are four class-rooms and a large hall seating 500 persons, besides a gallery over the rear half of it. At the other end of it is a stage with two dressing-rooms and other necessary adjuncts. This room is used on Sundays as well as on weekdays by various societies—a choral class among others—and is a convenient source of revenue.

It is impossible to lay down our Report without feeling that if each department of its work is by itself of little importance, it will doubtless be a useful agent in making every inhabitant of New Jersey and of the United States a more intelligent worker at his trade or surveyor of the economies around him.

PIERCING THE ISTHMUS OF PANAMA¹

THREE years ago the work of cutting through the Panama isthmus had barely commenced. The equatorial forests on the neck of land, 73 kilometres long, which marked the axis of the future interoceanic canal, had hardly been laid bare. The traveller who followed the primitive road met here and there some groups of cabins, with roofs of branches on poles, marking the site of a sounding or the improvised dwellings of a portion of the operators. Culebra, Emperador, Corosita, and Gamboa, which are now full of activity, were then almost desert, and on the coast of Colon alone the excavator traced in the marshy plains of Gatun his great track. The contrast to-day is great: a long file of workshops covers the space between the Atlantic and the Pacific. Twenty thousand workmen toil on the Cordillera, making the deep cutting for the canal. Side by side with this army, another more powerful army of colossal machines, excavators, dredges, locomotives, waggons, all the materials for transport, thousands of pairs of wheels, hundreds of kilometres of rails, mountains of coal, and shiploads of dynamite. Among the twenty-five workshops of the peninsula the attention is chiefly attracted to two points: the great rocky cutting at Culebra, which is to penetrate to a depth of 120 metres into the Cordillera, and the dam of the Chagres at Gamboa. At Culebra the previsions of M. de Lesseps have been realised: the mountainous mass which the canal will traverse is, for the most part, composed of rocks which are not very hard; repeated soundings by means of diamond perforators have shown that down to a

¹ Abstract from *La Nature*.